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Indian Standard

SPECIFICATION FOR GLASS ELECTRODES FOR DIRECT READING *p*H METER

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Indian Standard

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Indian Standard

SPECIFICATION FOR GLASS ELECTRODES FOR DIRECT READING *p*H METER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 7 December 1972, after the draft finalized by the Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard which is supplementary to IS : 2711-1965* deals with the dimensional, constructional and performance aspects of glass electrodes used with direct reading *p*H meters.

0.3 For guidance and information of the manufacturers of glass electrodes, method of checking the glass bulb and electrode elements by measuring the asymmetry of potential of electrode bulb and the potential of the internal Ag/AgCl electrodes is given in Appendix A.

0.4 The measuring equipment employed to carry out the measurements in accordance with this standard shall have an accuracy at least one order higher than that specified for the quantity under measurement.

0.5 In preparation of this standard, assistance has been derived from the following standards issued by the British Standards Institution:

BS 1647-1961 *p*H scale

BS 2586-1965 Glass electrodes for measurement of *p*H

0.6 This standard is one of series of Indian Standards on *p*H meters. Other standards so far published in this series are:

IS : 2711-1966 Direct reading *p*H meters (*revised*)

IS : 4309-1967 Methods of measurement on direct reading *p*H meters

0.7 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

---

*Direct reading *p*H meters (*revised*).

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard specifies the dimensions and constructional details and performance characteristics of glass electrodes used with direct reading *p*H meters. These characteristics are dc resistance, the electromotive efficiency, calibration of glass electrode and the alkali error.

2. CLASSIFICATION

2.1 The glass electrodes are grouped into the following classes according to their *p*H and temperature ranges:

Class	*p*H *Range* *p*H	*Temperature Range* °C
A	1 to 9	10 to 40
B	1 to 11	10 to 40
C	1 to 13	20 to 75
Special	(subject to agreement between the manufacturer and the purchaser)	

3. ELECTRODE STRUCTURE

3.1 The electrode should be either of the two forms, given in Fig. 1 and 2, consisting of the following parts:

a) *Bulb* — The *p*H sensitive portion of the electrode should preferably be spherical, spear head, or flat-bottom. The maximum dimensions across the cross-section should not be greater than the cap diameter [*see* **3.1** (d)].

b) *Electrode* — The total length of the electrode (including the cap) shall not exceed 140 mm.

c) *Stem* — The stem should consist of a glass tubing or two glass tubings sealed at the end with the annular portion providing the space for the screen to be connected to the screen of the main cable.

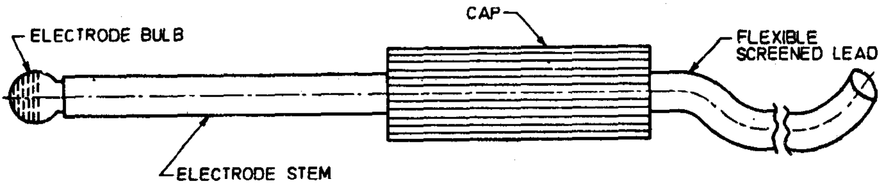
Length of the stem = 120 mm, *Max*

Outer diameter of the stem = Not exceeding 17 mm

d) *Cap* — The diameter of the cap should be approximately 20 mm.

e) *Cable* — The cable should be a screened cable having high insulation resistance. The flexibility of the cable should allow a bend of 20 mm radius without undue strain on the junction of the sealed cap. The length of the cable should at least be 500 mm. The insulation resistance of the cable with the cable connector shall be greater than 10^{13} ohms.

f) *Terminal* — The plug type terminal shown in Fig. 3 is recommended for the end connection of the cable.



Note — Shapes are typical but not obligatory.

Fig. 1 Glass Electrode

4. DC RESISTANCE

4.1 The dc resistance of the glass electrodes at 27 ± 1°C shall not exceed the values specified below when measured in accordance with **4.1.1**:

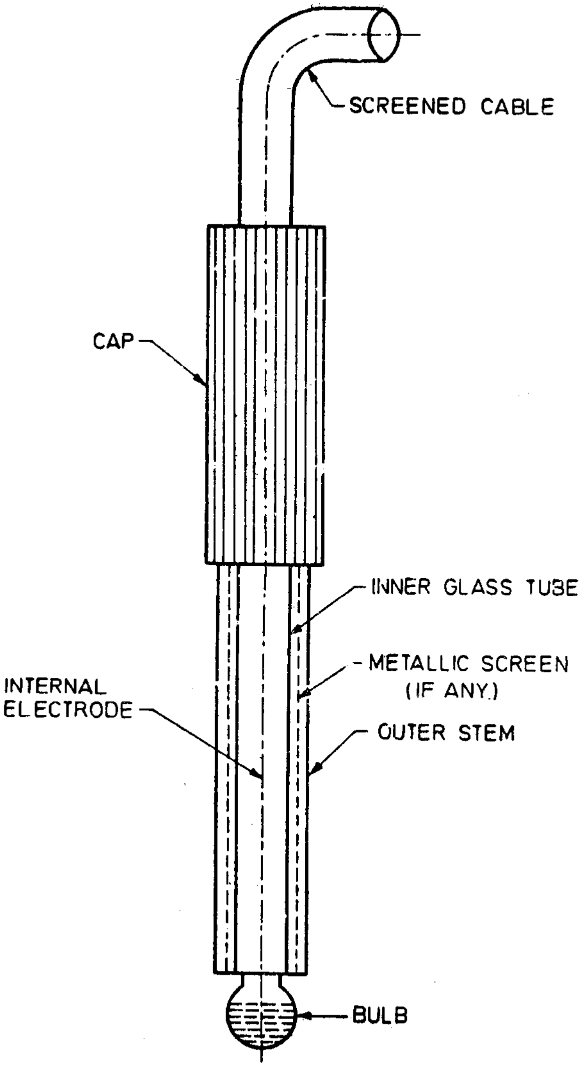
Class	*DC Resistance in M Ω*
A	400
B	600
C	800
Special	(subject to agreement between the manufacturer and the purchaser)

4.1.1 The dc resistance of the glass electrode may be measured using the set-up given in Fig. 4.

4.1.1.1 The *p*H electrode under test is immersed in any standard solution so as to give a rear full scale deflection on a *p*H meter connected across its terminals and calibrated in millivolts also. A known resistance R, 100 MΩ value, shall be connected across the *p*H meter terminals.

4.1.1.2 The voltage reading on the millivolts scale of *p*H meter shall be read with the external resistor R connected and disconnected. Let the voltage readings be V_2 and V_1. If r is the internal resistance of the glass electrode. Then

$$r = \frac{(V_1 - V_2)}{V_2} . R$$



NOTE — Shape is typical but not obligatory.

FIG. 2 SPECIAL GLASS ELECTRODE

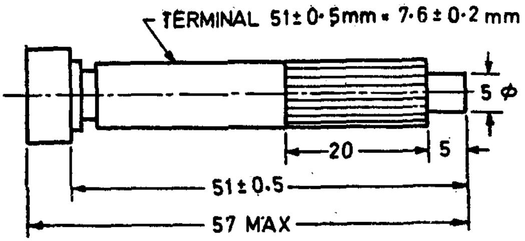
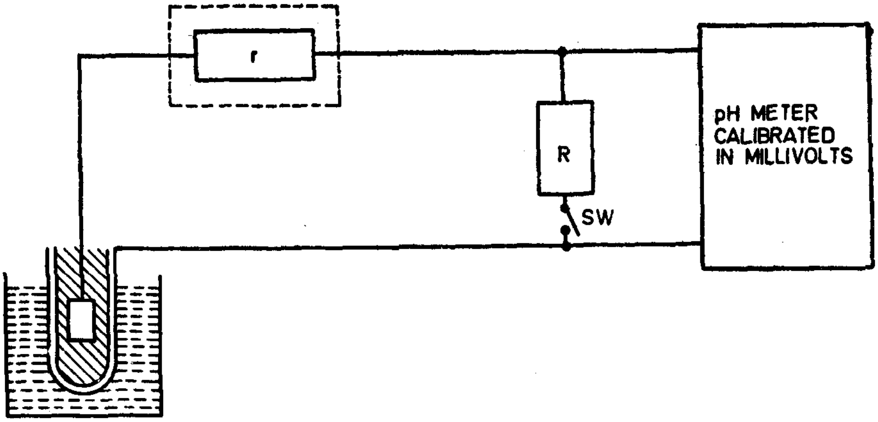


FIG. 3 TERMINAL



r = Internal dc resistance of the glass electrode
R = External resistor of 100 meghoms value
Sw = Switch

FIG. 4 SET-UP FOR MEASURING DC INTERNAL RESISTANCE OF GLASS ELECTRODE

5. ELECTROMOTIVE EFFICIENCY

5.1 The electromotive efficiency is defined as the ratio of the response of the glass electrode to that of the hydrogen electrode at the same temperature, that is

$$\text{Electromotive efficiency} = \frac{E_x - E_y}{E'_x - E'_y}$$

where E_x and E_y are the emf values in solutions X and Y at the same temperature by the glass electrode, and E'_x and E'_y have similar values by a hydrogen electrode.

NOTE — This ratio cannot exceed the value unity.

5.1.1 The electromotive efficiency of the electrode shall correspond to the value given below, when tested in accordance with Appendix B:

*p*H *Range*	*Temperature Range* °C	*Minimum Electromotive Efficiency*
1, up to and including 9	Below 50	0·995
	Above 50	0·900
Greater than 9, up to and including 11	,,	0·980
,, ,, 11, ,, ,, ,, 12	,,	0·950
,, ,, 12, ,, ,, ,, 13	,,	0·900
,, ,, 9, ,, ,, ,, 13	,,	Under consideration

6. CALIBRATION OF GLASS ELECTRODE

6.1 The glass electrode along with a standard reference electrode of saturated calomel electrode type shall indicate *p*H value of a secondary standard buffer solution to an accuracy of ±0·02 *p*H when standardized with a primary buffer solution of a *p*H differing from the secondary standard by more than 2 *p*H.

7. ZERO-EMF *p*H VALUE

7.1 The *p*H value at which the emf of the electrode system with a specified reference electrode is zero at 27°C, shall be stated. This should preferably be 7 *p*H.

8. ALKALI ERROR

8.1 Alkali error of the glass electrodes due to sodium ion concentration shall not exceed the limits specified below:

a) *Class A Electrodes* — No correction is necessary.

b) *Class B Electrodes* — At 11 *p*H and at 5 N sodium chloride solution, the alkali error should not exceed 0·05 *p*H.

c) *Class C Electrodes* — At 13 *p*H and at 5 N sodium chloride solution, the alkali error should not exceed 0·3 *p*H.

NOTE — The alkali error due to sodium ion concentration is a characteristic property of the composition of the glass. It would not be appreciable when the sodium concentration is less than 0·1 N and would be significant above 10 *p*H value (approximately) only.

8.1.1 A suitable correction curve relating *p*H reading and the correction to the reading for a given electrode also shall be provided by the manufacturer.

8.2 Method of Measurement — Using the glass electrode under test, the *p*H values of a standard solution of known *p*H value shall be determined at different sodium ion concentrations. The measurement shall be repeated with different solutions of known *p*H values to which sodium chloride solution of different concentrations were added. From these readings, the calibration curve should be obtained.

APPENDIX A

(*Clause* 0.3)

ASYMMETRY POTENTIAL OF ELECTRODE BULB AND POTENTIAL OF THE INTERNAL Ag/AgCl ELECTRODES

A-1. ASYMMETRY POTENTIAL OF ELECTRODE BULB

A-1.1 The asymmetry potential of the electrode bulbs used shall be within ±5·0 mV when measured in accordance with **A-1.1.1**.

A-1.1.1 Asymmetry potential of the electrode bulbs are measured with a precision electronic millivoltmeter by immersing the bulb in the same buffer solution as used within the bulb and employing two indentical Ag/AgCl electrodes in and outside the bulb.

A-2. POTENTIAL OF THE INTERNAL Ag/AgCl ELECTRODES

A-2.1 The potential of the internal Ag/AgCl electrodes (when used as the internal element of the glass electrode) should be within ±1·0 mV of the specified actual values when measured in accordance with **A-2.1.1**.

A-2.1.1 Potential of the Ag/AgCl is calculated by measuring the difference of potential at 27°C between Ag/AgCl and saturated calomel electrodes in a cell consisting of these two electrodes immersed in saturated KCl solution, and then deducting this potential difference in millivolts from the potential of saturated calomel at that temperature,

For example, if potential difference = 46·0 mV at 27°C

Then potential of Ag/AgCl = 268·0 + 46·0 = 222·0 mV at 27°C.

A-2.1.2 The Ag/AgCl electro-deposited portion should run through the entire regions of the stem where the internal liquid is free to be in contact with it.

APPENDIX B

(*Clause* 5.1.1)

MEASUREMENT OF ELECTROMOTIVE EFFICIENCY

B-1. MEASUREMENT

B-1.1 The emf E_x and E_y of the following cells in two different solutions *x* and *y* shall be measured both at the same temperature:

a)	Internal reference electrode A/Glass	Solution *x*	Saturated KCl/ Reference electrode B
b)	Internal reference electrode A/Glass	Solution *y*	Saturated KCl/ Reference electrode B

The entire *p*H sensitive portions of the glass electrodes shall be immersed in the solutions. The *p*H value of the two solutions should differ by 5 *p*H approximately.

B-1.2 The emf E'_x and E'_y of the two cells mentioned in **B-1.1** with the glass electrodes replaced by hydrogen electrode shall be measured under similar conditions. The electromotive efficiency is then computed from the formula:

$$\text{Electromotive efficiency } \beta = \frac{E_x - E_y}{E'_x - E'_y}$$

B-1.2.1 The value of $E'_x - E'_y$ may also be calculated from the following formula by using buffer solutions (*see* IS : 3225-1965*) for *x* and *y* solutions:

$$E'_x - E'_y = \frac{2{\cdot}302\,6\ RT}{F}\ (p\text{H of solution } x - p\text{H of solution } y)$$

where

R = gas constant,
T = absolute temperature in degrees kelvin, and
F = Faraday constant.

---

*Methods of preparation of buffer solutions.

NOTE — Numerical values of $\frac{2 \cdot 3026\, RT}{F}$ for various temperatures are given below:

Temp °C	2·302 6 RT/F
0	54·20
5	55·19
10	56·18
15	57·17
20	58·17
25	59·60
30	60·15
35	61·14
40	62·13
45	63·13
50	64·12
55	65·11
60	66·10
65	67·09
70	68·08
75	69·08
80	70·07
85	71·06
90	72·06
95	73·04

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